Final Technical Memorandum

Collection System Master Plan Addendum No. 4

Prepared for

City of Bend, Oregon

May 2011

Prepared in partnership with

Crane & Merseth Engineering/Surveying

Prepared by

CH2MHILL

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Submitted to

City of Bend, Oregon

May 2011

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PREPARED FOR: City of Bend, Oregon

PREPARED BY: CH2M HILL
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DATE: May 11, 2011

Introduction

In 2007, the City of Bend (City) completed preparation of the Collection System Master Plan (CSMP). This plan evaluated the capacity of existing public sewer collection and conveyance facilities to serve areas within the existing urban growth boundary (UGB), along with areas being considered at that time for possible inclusion in a UGB expansion area. The CSMP also identified system improvements necessary to serve lands and uses within the existing UGB that either had no publicly provided sanitary sewer service, or were as yet undeveloped.

In 2008, the City adopted addenda to the CSMP. These three addenda include:

Addendum No. 1. Final CSMP Executive Summary and the Executive Summary of a report proposing consideration of two alternate routes for the Parallel Plant Interceptor as recommended in the CSMP.

Addendum No. 2. Collection System Capital Improvement Program (CIP) Analysis and Report. This document provided an updated hydraulic model, including model re-calibration and revisions to the CIP projects list and their associated costs.

Addendum No. 3. Task 1.5 – Hamby Road Sewer Analysis. A report investigating the possibility of routing the Southeast Interceptor along the Hamehook, Hamby, and Ward Road rights-of-way as an alternative to the CSMP-recommended 27th Street route.

Purpose

This Collection System Master Plan Addendum No. 4 has been prepared in response to the remand issued by the Oregon Land Conservation and Development Commission (LCDC) in their review of the City's formal request to expand the UGB. This directive (remand) requires the City to amend sections of the CSMP to bring it into compliance with state regulations. Specifically, this addendum was prepared to bring the 2007 CSMP into to compliance with Oregon's Statewide Planning Goals and Guidelines, Goal 11. LCDC's November 2010 partial acknowledgement/remand order allows the City to adopt a sewer Public Facilities Plan that considers potential growth through 2028 and within the City's existing UGB.

Addendum No. 4 is intended for use in context with the CSMP and Addendum No. 2 with respect to hydraulic model development and existing system analysis. Addendum No. 4 supersedes all earlier works when the two address similar topics, parameters, criteria, findings and recommendations for planning through 2028. Specifically, the CSMP is amended so that the only improvements included in the plan are the projects listed in Addendum No. 4. Any references in the original CSMP, Addendum No. 2, or Addendum No. 3, whether in map or text, to service areas outside of the existing UGB are superseded. The only areas served under the CSMP as amended by this addendum are areas within the existing UGB and other areas currently served. Furthermore, system improvements identified in Addendum No. 4 are intended to represent service for population growth through 2028. Additional improvements not identified in this addendum may be required to serve ultimate build-out conditions for the City of Bend within the existing UGB.

Additionally, this addendum clarifies that wherever the term "Westside Interceptor" was used in the CSMP, that term is hereby superseded by the term "Central Interceptor" to better depict the geographic location of the Central Interceptor facilities. All references to "Westside Interceptor" in the CSMP or other related documentation based on the CSMP, shall be referred to as the "Central Interceptor."

Basis of Planning

Model

The City's collection system model was constructed and calibrated in 2005. The model simulations are performed using the InfoSWMM (MWH Soft) software, which uses the industry standard SWMM 5 hydraulic engine developed by the U.S. Environmental Protection Agency (EPA). In 2007, the model was re-calibrated to account for basin-specific responses to wet weather inflow and infiltration. Additionally, the 2007 model calibration implemented field-verified dry weather diurnal patterns. Wet weather parameters and dry weather diurnal patterns were applied to growth areas to develop future system improvements as documented in the CSMP and Addendum No. 2.

The City's CSMP and existing system models were used for this analysis. These models were provided by City staff in December 2010. Two model days were considered for each scenario, including a dry weather day, and a "dry plus wet weather" day. Wet weather conditions were evaluated for a 10-year, 24-hour summertime storm event.

Population Estimates and Growth Boundary

Two population estimates are referenced in the CSMP and Addendum No. 2. These estimates are defined below and presented in Table 1:

1. **Projected Growth:** This projection assumes a varied growth rate through 2030, with a final population of 119,009. The population growth rates are based on the City of Bend's adopted population forecast, as included in the Deschutes County Coordinated Population Forecast.

2. **Maximum Growth:** This is the maximum population as established in the CSMP. This projection assumes a 5 percent growth rate through 2030, with a total population of 238,162.

The maximum population projection of 238,162 was higher than the City's coordinated population forecast of 109,389 for 2025. The City had also extended the projected forecast out to 2030 to develop a forecast of 119,009 for infrastructure planning.

The maximum projection of 238,162 was prepared solely for a technical analysis comparing system needs of the adopted forecast with a much higher, theoretical population based on an annual average growth rate that seems unlikely to occur. The fact that this much higher projection was analyzed does not in any way indicate that Bend's urban area could or should accommodate a population of 238,162 for the 2008-2028 planning period. The higher forecast was developed to size infrastructure for a longer planning period.

Collection system improvements in the CSMP assumed the maximum growth rate through 2030 with development inside the City's UGB and within the Urban Area Reserve (UAR). Addendum No. 2 analyzed and compared improvements at both growth rates through 2030 with development inside the City's UGB and within the UAR.

Addendum No. 4 addresses improvements required for the City's sewer collection system, assuming a 2028 population forecast of 115, 063 for the current UGB. The forecast of 115,063 is justified because it represents the City's 2028 coordinated population forecast that was acknowledged by the LCDC in the January 8, 2010, Director's report, and also acknowledged by LCDC in their final partial acknowledgement/ remand order dated November 3, 2010. This is the same forecast the City used for estimating future land needs for housing, employment, and other land uses consistent with Goal 14 and OAR 660-024. Improvements identified in this addendum are not sized to serve population growth beyond 2028.

Addendum No. 4 addresses sanitary sewer service within the existing UGB. Facilities discussed in this addendum are not sized to serve areas outside the existing UGB.

TABLE 1
Growth Rates for the City of Bend, Oregon
Bend Collection System Master Plan Addendum No. 4

Year	Projected Population	Projected Growth Rate	Maximum Population	Maximum Growth Rate
2000 (actual)	52,800	-	52,800	-
2005 (actual)	70,330	4.74%	70,330	5.00%
2010 (estimate)	81,242	2.52%	89,761	5.00%
2015 (estimate)	91,158	2.33%	114,560	5.00%
2020 (estimate)	100,646	2.00%	146,211	5.00%
2025 (estimate)	109,389	1.68%	186,606	5.00%
2028 (estimate)	115,063	1.70%	216,020	5.00%
2030 (estimate)	119,009	1.70%	238,162	5.00%

Notes:
Data in this table taken from Table 2-10 of the CSMP.

The CSMP divides the growth boundary into nine study areas. Addendum No. 4 maintains the nine study area boundaries (Figure 1).

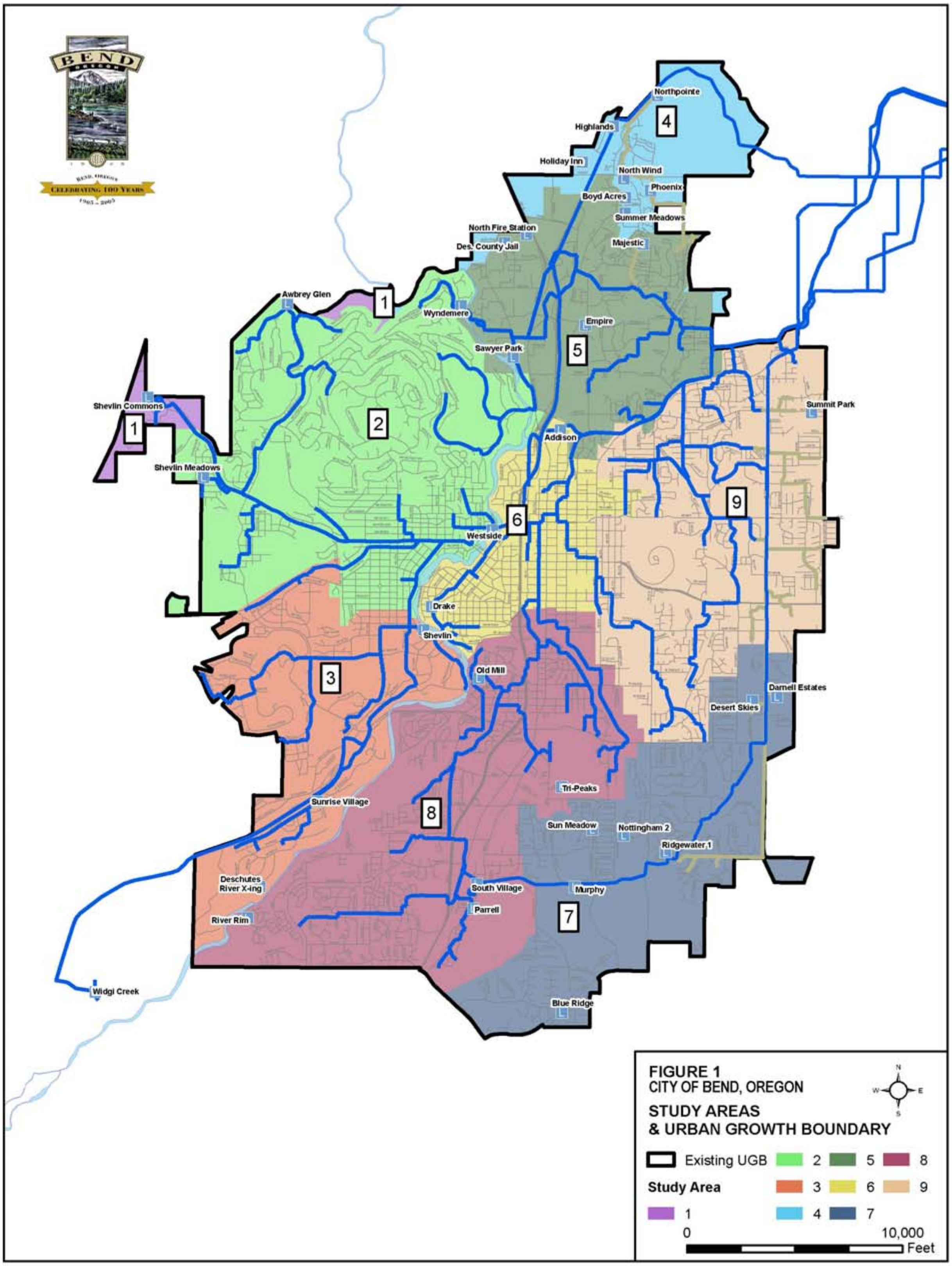

FIGURE 1
CITY OF BEND, OREGON
STUDY AREAS
& URBAN GROWTH BOUNDARY

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Dry Weather Flow Loading

The dry weather flow loading for the City's master plan model was revised to reflect the population estimate of 115,063 within the existing UGB. Average flows were generated from parcel/land use data provided by the City. Average residential flows were first assigned to developed residential parcels. To satisfy the 2028 residential flow estimate, 25 percent of undeveloped residential parcels were also assigned average flows. The combination of loading from existing developed parcels and 25 percent of existing undeveloped parcels resulted in the full 2028 average flow estimate. The flows assigned to undeveloped parcels were distributed across the system based on parcel density. Residential flow assumptions are presented in Table 2 and Figure 2.

The residential loading assumptions do not imply that any policy decision has been made to plan for development on only 25 percent of vacant residential land. Rather, this assumption simply allows for allocation of the 2028 population forecast to areas that are currently undeveloped for the sole purpose of analyzing likely flows during the planning period, if all of the estimated 2028 population were accommodated within the current UGB. In so doing, this addendum makes no determination as to how much existing undeveloped residential land is actually suitable or available for development. Neither does it suggest that there is any correct or preferred estimate of the ultimate capacity of the current UGB for housing or for employment. Such determinations are properly left to a buildable lands inventory, prepared in compliance with state land use laws governing the establishment and expansion of UGBs.

Average commercial and industrial flows were assigned to parcels based on per-acre water usage based on a review of water billing records in the CSMP. One hundred percent of commercial and industrial flows were applied to the 2028 model. This is a conservative assumption based on trends in tourism and commuting within the City. A lesser application of commercial and industrial flows was considered to match potential residential growth; however, this resulted in less than a 10 percent decrease in overall system flows. In other words, 100 percent of vacant commercial and industrial lands were assumed to be developed by 2028. A lesser development percentage would have resulted in less than a 10 percent differential in average flow rate. Non-residential flow assumptions by land use are presented in Table 3 and Figure 2.

Average flows were assigned to model nodes from the City parcel layer based on service areas defined in the CSMP. Diurnal patterns established during the 2007 model calibration were used.

TABLE 2
Average Residential Flow Assumptions Used for CSMP Addendum No. 4 Analysis
Bend Collection System Master Plan Addendum No. 4

Residential Land Use Assumptions	
People per Unit (CSMP)	2.5
Per Capita Water Usage[1]	100 gallons per capita day
Number of Existing Units [City Parcel Database]	35,792
2028 Population Estimate	115,063

TABLE 2
Average Residential Flow Assumptions Used for CSMP Addendum No. 4 Analysis
Bend Collection System Master Plan Addendum No. 4

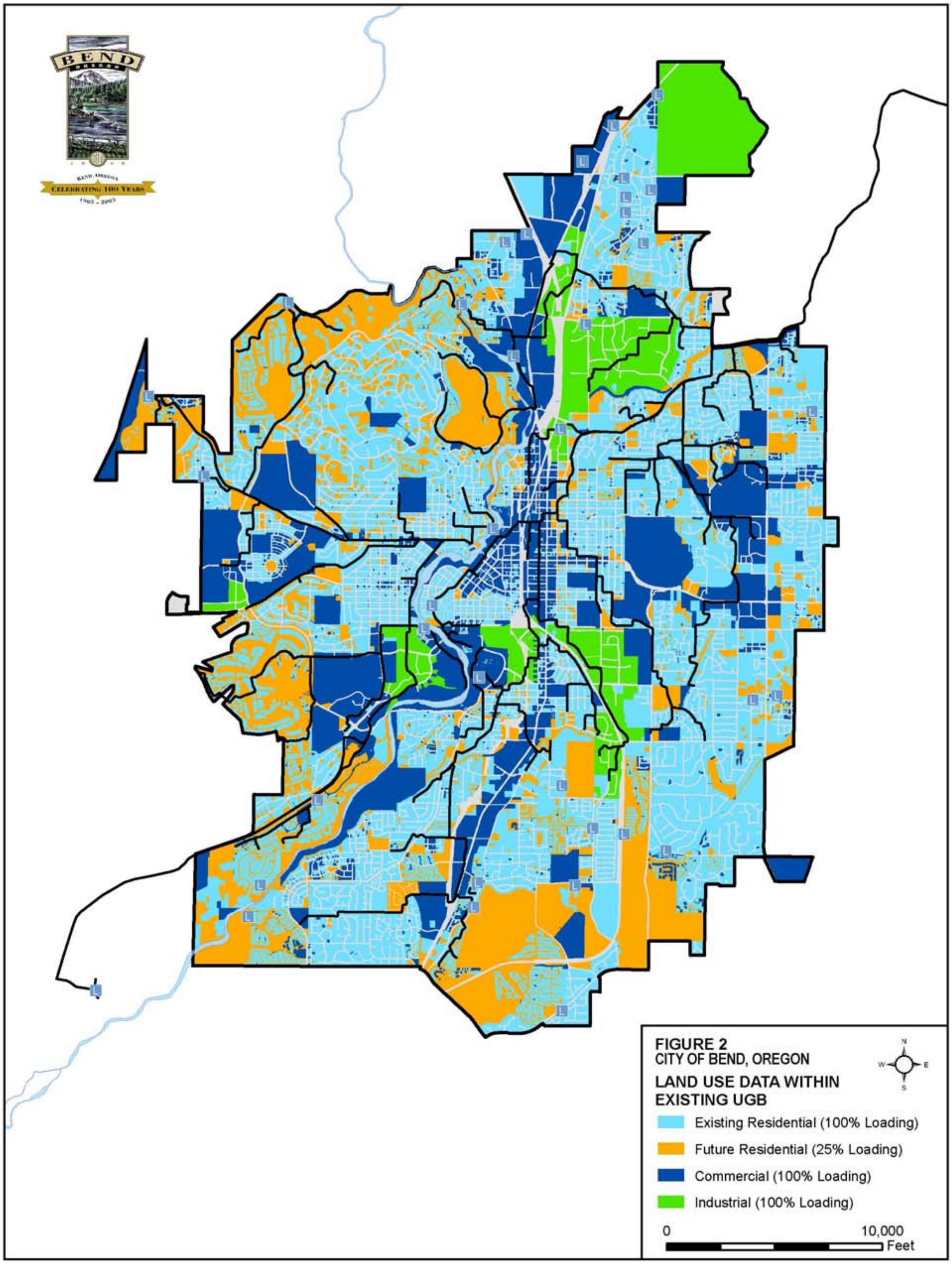
Residential Land Use Assumptions	
Number of Undeveloped Units [City Parcel Database]	40,936
Number of Undeveloped Units with Potential for Development by 2028 [population limited to 115,063]	10,053
Ratio of Undeveloped Units with Potential Development by 2028 to Total Undeveloped Units	0.25

Notes:

[1] In the CSMP, several factors are applied to per capita water usage including a reduction factor for partial year occupancy and a multiplication factor for seasonal peaking. These factors essentially cancelled one another; therefore, no factors were applied for this analysis.

TABLE 3
Average Non-Residential Flow Assumptions Used for CSMP Addendum No. 4 Analysis
Bend Collection System Master Plan Addendum No. 4

Non-Residential Flow Assumption by Land Use	
Land Use	**Average Flow (gallons per acre day)**
Central Business	3,228
Commercial Convenience	2,215
Commercial General	799
Commercial Limited	1,746
Industrial General	709
Industrial Limited	698
Industrial Park	709
Mixed Employment	2,149
Mixed Use Riverfront	445
Public Facility	130
Professional Offices	1,746


BEND
OREGON
CELEBRATING 100 YEARS
FIGURE 2
CITY OF BEND, OREGON
LAND USE DATA WITHIN
EXISTING UGB
Existing Residential (100% Loading)
Future Residential (25% Loading)
Commercial (100% Loading)
Industrial (100% Loading)
0
10,000
Feet
N
S
E
W
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Wet Weather Flow Loading

The wet weather flow component of the model consists of a storm event, sewershed acreage (wet weather area of impact), and rainfall-derived infiltration and inflow (RDII) unit hydrograph. For the master plan model, the peak of the 10-year, 24-hour design storm (1.3 inch, Natural Resource Conservation Service [NRCS] Type II distribution) is set to coincide with the sanitary sewage diurnal peak for dry weather throughout the collection system. This peak occurs on a weekend day at 10:00 a.m. The design storm recurrence interval and depth reflect historical precipitation data compiled during spring and summer months only.

The variability in the wet weather component of the model is a result of basin-specific unit hydrographs and sewershed areas. The unit hydrographs defined during the 2007 model calibration were assigned to model nodes by sub-basin. Sewersheds in the existing system were defined by placing a 20-foot buffer around all system pipes. A correlation was established between sewershed area and developed parcel acreage. This correlation was used to extrapolate sewershed areas for the 2028 growth horizon in the master plan model.

Design Criteria

The City criteria for determining system deficiencies are shown in Table 4. These criteria were used to determine deficiencies and size improvements for the Addendum No. 4 CIP.

TABLE 4
Design Criteria Used for CSMP Addendum No. 4 Analysis
Bend Collection System Master Plan Addendum No. 4

Standard[1]	Category	Criteria
Primary	During peak dry weather flows, d/D	<= 0.8
	During peak wet weather flows, maximum surcharge (clearance from water surface to manhole rim)	>= 2.5 ft
	Shallow Manhole (crown of pipe to rim < 2.5 ft), during peak wet weather flows, maximum surcharge	>= 0.5 ft
	Pump Station firm capacity	Lift stations have capacity to pump at flows greater than or equal to peak hour flows with largest pump out of service
Secondary	Maximum force main velocity	6-8 ft/sec
	Maximum gravity pipeline velocity	< 10 ft/sec or anchored appropriately for extreme slopes
	Minimum cleansing/scouring velocity, gravity pipeline and force main	2 ft/sec

Notes:

[1] Primary standards directly indicate whether infrastructure has adequate capacity. System improvements were identified based on primary standards. Secondary standards indirectly indicate whether infrastructure has adequate capacity. System improvements were considered based on secondary standards, but were typically selected only if a primary standard deficiency could be simultaneously eliminated.

Cost Criteria

Cost criteria were summarized in Technical Memorandum 3.6, Cost Criteria in the CSMP. CH2M HILL updated unit costs used from the original CSMP to October 2007 dollars for a project prioritization effort in January 2008. The original and updated costs were based on local contractor information and industry trends. These October 2007 unit costs were the basis of the Addendum No. 2 cost estimates.

The work performed for the updated cost estimates in this Addendum No. 4 are in accordance with the following qualifications.

The estimate was prepared in accordance with the guidelines of American Association of Cost Engineers (AACE) International, the Association for the Advancement of Cost Engineering. AACE International’s Class 4 Estimate is defined as follows:

> ***Class 4 Estimate.*** *This estimate is prepared based on limited information, where the preliminary engineering is from 1 to 5 percent complete. Detailed strategic planning, business development, project screening, alternative scheme analysis, confirmation of economic and or technical feasibility, and preliminary budget approval are needed to proceed. Examples of estimating methods used would be equipment and or system process factors, scale-up factors, and parametric and modeling techniques. The development of this type of estimate requires more time expended in its development. The expected accuracy ranges for this class estimate are –15 to –30 percent on the low side and +20 to +50 percent on the high side.*

The cost estimates shown, which include any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. In addition, the cost estimates are “rough cost estimates” consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help achieve proper project evaluation and adequate funding.

For Addendum No. 4, the 2007 unit costs for construction are escalated to December 2010 dollars using the *Engineering News-Record* Construction Cost Index (ENR CCI) with an escalation factor of 1.11 (Dec 2010/Oct 2007= 8952/8045).

Project costs calculated for this Addendum No. 4 also included the following markups:

- 20 percent for other (such as easements and crossings)
- 25 percent for engineering, legal, and administration
- 30 percent for contingency

2010 escalated unit costs for construction are shown in Tables 5a through 5c.

TABLE 5A
2010 Escalated Unit Costs for Pipelines ($/linear-ft)[1]
Bend Collection System Master Plan Addendum No. 4

Pipe Size (inch)[2]	Material	Installation Depth Category					Surface Restoration Road Category		
		0-10	10-15	15-20	20-25	25-30	Local	Arterial	Dirt/Gravel
8	$3.55	$84.57	$143.54	$239.24	$370.49	$492.94	$9.41	$21.38	$4.98
12	$7.97	$100.15	$161.35	$254.82	$374.25	$492.94	$9.41	$21.38	$4.98
18	$21.14	$115.73	$179.15	$270.40	$380.56	$492.94	$10.75	$24.43	$5.68
24	$30.04	$131.30	$196.96	$285.97	$387.23	$519.65	$12.09	$27.49	$6.40
30	$52.30	$146.88	$214.76	$301.55	$393.91	$546.36	$16.12	$36.65	$8.54
36	$64.54	$154.67	$223.66	$309.34	$397.25	$559.71	$18.15	$41.23	$9.60
42	$75.67	$162.46	$232.56	$317.13	$400.59	$573.06	$20.15	$45.81	$10.66
48	$100.15	$166.91	$233.68	$318.24	$403.92	$580.85	$20.15	$45.81	$10.66

Notes:

[1] ENR-CCI escalation factor of 1.11 (Dec 2010/Oct 2007= 8952/8045).

[2] Bypass pumping costs based on pipeline length, $14.47 for diameter < 24-inch and $18.92 for diameter >= 24-inch.

TABLE 5B
2010 Escalated Unit Costs for Manholes ($/each)[1]
Bend Collection System Master Plan Addendum No. 4

Manhole Size (inch)[2]	Material[3]	Material Depth Category					Installation Depth Category				
		0-10	10-15	15-20	20-25	25-30	0-10	10-15	15-20	20-25	25-30
48	Concrete	$1,161	$1,517	$1,889	$2,223	$2,557	$3,260	$4,017	$5,085	$6,109	$7,945
60	Concrete	$2,858	$4,009	$5,161	$5,573	$6,374	$4,484	$5,577	$7,199	$8,791	$11,127
72	Concrete	$3,291	$4,638	$5,984	$7,331	$8,065	$5,898	$7,633	$9,703	$11,433	$14,466
63	HDPE	$12,312	$13,797	$15,282	$16,767	$18,252	$2,242	$2,789	$3,600	$4,395	$5,564
72	HDPE	$18,488	$22,131	$25,773	$29,416	$33,058	$3,934	$5,091	$6,472	$7,626	$9,649

Notes:

[1] ENR-CCI escalation factor of 1.11 (Dec 2010/Oct 2007= 8952/8045).

[2] Reconnection cost of $1,060 applied to all existing system concrete manholes.

[3] Concrete manhole costs were applied to existing system improvements. HDPE manhole costs were applied to interceptor improvements.

TABLE 5C
2010 Escalated Unit Costs for Force Mains ($/linear-ft)[1]
Bend Collection System Master Plan Addendum No. 4

Pipe Size (inch)[1]	Material	Installation Depth Category	Surface Restoration Road Category		
		0-10	Local	Arterial	Dirt/Gravel
8	$3.55	$84.57	$9.41	$21.38	$4.98
12	$7.97	$100.15	$9.41	$21.38	$4.98
18	$21.14	$115.73	$10.75	$24.43	$5.68
24	$30.04	$131.30	$12.09	$27.49	$6.40
30	$52.30	$146.88	$16.12	$36.65	$8.54
36	$64.54	$154.67	$18.15	$41.23	$9.60
48	$100.15	$166.91	$20.15	$45.81	$10.66

Notes:

1 ENR-CCI escalation factor of 1.11 (Dec 2010/Oct 2007= 8952/8045).

2 Bypass pumping costs based on pipeline length, $14.47 for diameter < 24-inch and $18.92 for diameter >= 24-inch.

For Addendum No. 4, pump station improvement costs were not independently estimated, resulting in a reduced level of accuracy. This reduction in accuracy is related to the uncertainty associated with the original pump station estimates in the 2006 CSMP, which is now carried through in the factors applied to arrive at 2010 cost estimates. The 2006 CSMP pump station improvements costs (identified by MWH in the original CSMP) are either reduced or increased based on the "six-tenths capacity factor" rule. The six-tenths factor rule is defined below (see U.S. Department of Energy document DOE G 430.1-1, Chapter 20, page 20-4):

> If a new piece of equipment is similar to one of another capacity for which cost data are available, good results (cost estimates) can be obtained from a scaling factor by using the logarithmic relationship known as the "six-tenths-factor rule." According to this rule, if the cost of a given unit at one capacity is known, the cost of a similar unit with X times the capacity of the first is approximately $(X)^{0.6}$ times the cost of the initial unit.
>
> Cost of equip. *a* = cost of equip. *b** (capac. equip. *a*/ capac. equip. *b*)$^{0.6}$

Additionally, the 2006 CSMP pump station costs are escalated to December 2010 dollars using the *Engineering-News Record* 20-Cities Construction Cost Index (ENR CCI) with an escalation factor of 1.06 (Dec 2010/2006 [as reported in CSMP] = 8952/8449).

Capital Improvements

The City's collection system model was used to identify and evaluate system deficiencies and propose improvements based on the revised 2028 flows (115,063 population). Existing pipeline upgrades and interceptor improvements were sized to satisfy surcharge clearance, maximum velocity, and maximum depth over diameter (d/D) criteria. For interceptor improvements, the minimum scouring velocity criteria were also considered. Pump station improvements were sized to satisfy firm capacity requirements. This means that peak-hour flows can be pumped with the largest pump out of service. The analysis considered the main collector line only. New and existing service collectors and laterals were not considered for improvement.

Existing system gravity and force main improvements and costs are summarized in Table 7A and Figure 3. Lift station improvements and costs are summarized in Table 7B and Figure 3. Improvement identifiers match the identifiers used in the CSMP and Addendum No. 2. Improvements are organized into the nine study areas defined in the CSMP and shown in Figure 1.

The Westside Pump Station is a large regional lift station serving most of the area west of the Deschutes River. The operation of the Westside Pump Station was confirmed through limited field testing during March 2011 when flows and force main pressures were measured over the full range of pump station capacity and compared with the InfoSWMM model results over a similar range of operating conditions.

The results of the field testing indicate that the Westside Pump Station has limited available capacity for future growth as currently configured. The current peak flow rate estimate into the pump station is 2,600 gpm compared to the firm capacity as observed (with largest pump out of service) of 3,000 gpm.

For the 2028 analysis, the Westside Pump Station was not identified as a hydraulic deficiency assuming that the pumps are operating at their theoretical capacity (design point on pump curves) and assuming that the Central Interceptor, North Interceptor, and Parallel Plant Interceptor are all constructed downstream of the pump station. Pump improvements ranging from impeller replacement to full pump replacement may be required for operation at the theoretical capacity.

Once the Central Interceptor and North Interceptor are constructed, the Westside Pump Station will pump directly into the new Central Interceptor system via a 21-inch Central Interceptor force main as proposed in the CSMP Addendum No. 4. Westside Pump Station improvements and modified operations such as variable speed drive settings should be coordinated with the design and construction of the downstream interceptors, including the Central Interceptor, North Interceptor, and Parallel Plant Interceptor. Any interim condition where the downstream interceptors are not fully constructed may result in a hydraulic deficiency beginning at the Westside Pump Station and going downstream, and potentially backing up into the collection system upstream of the Westside Pump Station.

Additionally, the City has a goal to maximize gravity sewer conveyance and to minimize pump station usage throughout the City to minimize long-term operations and maintenance (O&M) costs. Any proposed interim improvement at the Westside Pump Station prior to construction of the downstream interceptors should consider a 50-year cost analysis that includes O&M costs. The overall cost estimate for improvements downstream of the Westside Pump Station including the pump station and all downstream interceptors is $39,774,000 in 2010 dollars using the costing framework described in this memorandum (see Table 6).

TABLE 6
Cost of Westside Pump Station and Downstream Interceptor Improvements
Bend Collection System Master Plan Addendum No. 4

Improvement	Cost[1]
Westside Pump Station	$3,994,000
Central Interceptor	$11,725,000
North Interceptor	$8,113,000
Parallel Plant Interceptor (Option B)	$15,942,000
Total	$39,774,000

Notes:
[1] All costs are order-of-magnitude, -30% to +50% in 2010 dollars. More cost specifics for pump station and interceptor improvements are provided in Tables 7B and 7C.

The CSMP and Addendum No. 2 identified Parrell Pump Station as an improvement. Discussions with City staff (January 2011) have revealed that this pump station has been decommissioned. This analysis assumes that future and existing flows from the applicable service area are conveyed by gravity to the Southeast Interceptor without additional improvements.

The CSMP identified new interceptor improvements including the Central, North, Southeast, and Parallel Plant interceptors. The interceptors provide the following benefits:

1. Elimination of pump stations in existing and developing areas within the UGB (primarily north and south perimeter).
2. Gravity service to developing areas within the UGB.
3. Off-loading of existing interceptors to allow for in-fill growth in the central area of the City.

The interceptors were considered as viable improvements for Addendum No. 4. The Southeast and Central interceptors can be constructed on lands within the City's UGB. In Addendum No. 4, the North Interceptor is only considered east of Highway 97. Sixty-two percent of the North Interceptor east of Highway 97 is aligned on lands within the City's existing UGB. Because the City's Wastewater Reclamation Facility (WRF) is located outside the existing UGB, and natural topography constraints, the remaining 38 percent of the North Interceptor and 100 percent of the Parallel Plant Interceptor require the use of lands outside of the existing UGB. Three alternative alignments were considered for the Parallel Plant Interceptor. These alternatives are described below and presented in Figure 3:

1. **Option A:** An alignment south of the existing Plant Interceptor. The alignment follows the shortest route and natural ground contours from the Southeast Interceptor to the WRF. A 3,100-foot connection extends from the North Interceptor to the Option A Parallel Plant Interceptor.

2. **Option B:** An alignment south of the existing Plant Interceptor. The alignment follows potential and existing roadways from the Southeast Interceptor to the WRF. A 2,000-foot connection extends from the North Interceptor to the Option B Parallel Plant Interceptor.
3. **Option C:** The alignment identified in the CSMP, west and north of the existing Plant Interceptor. The alignment is parallel to the existing Plant Interceptor northeast of Pioneer Loop. A 10,000-foot connection extends from the Southeast Interceptor to the North Interceptor west of the existing Plant Interceptor.

A comparative analysis of the Parallel Plant Interceptor options can be found in a memorandum entitled “Parallel Plant Interceptor Conceptual Design Task 1.3.2. PPI Routing Options Analysis and Comparison [December 2010].” The headworks at the WRF have always resulted in a submerged outlet condition from the collection system, which causes a backwater effect through the existing Plant Interceptor and Parallel Plant Interceptor. The new headworks that were placed on-line in 2008 had a slightly lower finished floor elevation but still cause backwater conditions in the Plant Interceptor and will in any of the Parallel Plant Interceptor options. The inverted siphon structure in the Plant Interceptor is currently the limiting hydraulic constraint when considering peak flows from the collection system to the WRF. Some improvements may be required to prevent overflows in the existing Plant Interceptor. These improvements require additional field work and design level analysis and are not presented in this Addendum No. 4.

Interceptor improvements and costs are summarized in Table 7C and Figure 3.

TABLE 7A
Existing System Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Old Pipe Diameter (inch)	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
2--2	10	12	5 - 41	2,900	$627,000	11	$76,000	$141,000	$211,000	$316,000	$1,370,000
2--2b	10	15	5 - 10	900	$131,000	3	$16,000	$30,000	$44,000	$67,000	$288,000
2--7	27	30	16 - 22	1,000	$431,000	3	$42,000	$95,000	$142,000	$213,000	$922,000
2--8	21	24	7 - 21	2,500	$569,000	8	$79,000	$130,000	$194,000	$292,000	$1,264,000
2--10	30	36	16 - 22	600	$237,000	1	$15,000	$50,000	$76,000	$113,000	$492,000
2--14	8	10	4 - 52	1,200	$485,000	12	$97,000	$117,000	$175,000	$262,000	$1,136,000
2--14b	8	12	5 - 15	0	$5,000	0	$0	$1,000	$2,000	$2,000	$10,000
2--15	8	10	4 - 9	700	$90,000	3	$16,000	$21,000	$32,000	$48,000	$207,000
2--15b	8	12	4 - 10	800	$104,000	4	$23,000	$25,000	$38,000	$57,000	$247,000
2--16 (FM)	4	6	1 - 7	400	$39,000	0	$0	$8,000	$12,000	$18,000	$76,000
3--2	8	10	2 - 3	500	$61,000	1	$5,000	$13,000	$20,000	$30,000	$130,000
3--3	10	12	3 - 15	2,000	$291,000	9	$56,000	$69,000	$104,000	$156,000	$678,000
3--3b	10	15	5 - 15	1,600	$270,000	4	$24,000	$59,000	$88,000	$132,000	$574,000
5--3	10	12	4 - 13	3,700	$514,000	7	$41,000	$111,000	$166,000	$250,000	$1,082,000
5--4	8	10	4 - 11	500	$63,000	2	$12,000	$15,000	$23,000	$34,000	$147,000
5--8	8	10	4 - 14	1,900	$263,000	6	$35,000	$60,000	$89,000	$134,000	$581,000

TABLE 7A
Existing System Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Old Pipe Diameter (inch)	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
6--1	8	12	19 - 20	100	$27,000	0	$0	$5,000	$8,000	$12,000	$53,000
6--2	12	15	3 - 23	2,200	$517,000	10	$73,000	$118,000	$177,000	$266,000	$1,151,000
8--1	10	12	4 - 10	1,500	$192,000	3	$18,000	$42,000	$63,000	$94,000	$409,000
8--1b	8	10	7 - 8	200	$24,000	1	$5,000	$6,000	$9,000	$13,000	$58,000
8--2	12	15	4 - 19	3,000	$635,000	11	$72,000	$141,000	$212,000	$318,000	$1,377,000
8--7	8	10	7 - 10	200	$21,000	1	$5,000	$5,000	$8,000	$12,000	$51,000
9--3	12	15	6 - 19	1,600	$277,000	6	$39,000	$63,000	$95,000	$142,000	$616,000
9--8	12	15	4 - 6	500	$74,000	3	$16,000	$18,000	$27,000	$41,000	$177,000
Total				**30,500**	**$5,947,000**	**109**	**$765,000**	**$1,343,000**	**$2,015,000**	**$3,022,000**	**$13,096,000**

Notes:

Improvements represent existing system upgrades to service population and flow estimates through 2028 within the UGB. Improvements reflect major collectors and interceptors. Additional improvements may be required to minor collectors and service lines based on development needs. All costs are order-of-magnitude, -30% to +50% in 2010 dollars.

TABLE 7B
Pump Station Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Lift Station Name	Existing Firm Capacity from CSMP (gallons per minute)	Applicable 2028 Peak Flow Estimate (gallons per minute)	Improvement	Improvement Description	Cost
1.PS01	Shevlin Commons	118	202	Upgrade	New Pumps with increased capacity	$85,000
2.PS01	Awbrey Glen	450	1,089	Upgrade	New Pumps with Increased Capacity	$448,000
2.PS04	Shevlin Meadows	145	206	Upgrade	New Pumps with Increased Capacity	$43,000
2.PS05	Shevlin Meadows			Upgrade	Activated Carbon Odor Scrubber	$26,000
3.PS01	Sunrise Village #1	250	386	Upgrade	New Pumps with Increased Capacity	$61,000
3.PS02	Widgi Creek	297		Flow Testing and Further Evaluation	A flow test performed by City staff showed station not able to pump design capacity of 450 gpm. The problem is likely caused by conflicting hydraulic grade level from Sunrise Village pump station. Additional flow testing and evaluation recommended.	$16,000
4.PS01	Boyd Acres	65		Decommission	New 460-ft 8” Sewer	$76,000
4.PS02	Boyd Acres	65		Decommission	Removal of Pump Station	$26,000
4.PS03	Highlands	250		Decommission	New 2512-ft 8” Sewer	$416,000
4.PS04	Highlands	250		Decommission	Removal of Pump Station	$26,000
4.PS05	Holiday Inn	Unknown		Decommission	New 382-ft 8” Sewer	$64,000
4.PS06	Holiday Inn	Unknown		Decommission	Removal of Pump Station	$11,000
4.PS07	Northpointe	265		Decommission	New 350-ft 8” Sewer	$58,000

TABLE 7B
Pump Station Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Lift Station Name	Existing Firm Capacity from CSMP (gallons per minute)	Applicable 2028 Peak Flow Estimate (gallons per minute)	Improvement	Improvement Description	Cost
4.PS08	Northpointe	265		Decommission	Removal of Pump Station	$26,000
4.PS09	North Wind	270		Decommission	New 400-ft 8" Sewer	$67,000
4.PS10	North Wind	270		Decommission	Removal of Pump Station	$26,000
4.PS11	Phoenix	228		Decommission	Removal of pump station including the intertie between Phoenix and Northpointe Pump station basin	$43,000
4.PS12	Summer Meadows	125		Decommission	New 450-ft 8" Sewer	$74,000
4.PS13	Summer Meadows	125		Decommission	Removal of Pump Station	$26,000
5.PS02	Empire	50	85	Upgrade	Installation of New Pumps	$25,000
5.PS03	Deschutes County Jail	115		Decommission	8" Gravity Sewers discharging to the North Interceptor	$26,000
5.PS04	Majestic	265		Decommission	New 1800-ft 8" Sewer	$298,000
5.PS05	Majestic	265		Decommission	Removal of the Pump Station	$26,000
5.PS06	North Fire Station	Unknown		Decommission	8" Gravity Sewers discharging to the North Interceptor	$26,000
6.PS01	Drake Pump Station	650	406	Replacement	Replace Drake Pump Station with new station	$364,000

TABLE 7B
Pump Station Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Lift Station Name	Existing Firm Capacity from CSMP (gallons per minute)	Applicable 2028 Peak Flow Estimate (gallons per minute)	Improvement	Improvement Description	Cost
6.PS02	Addison Pump Station	100	448	Replacement	Correct grade problem at 4th and Addison	$609,000
7.PS02	Nottingham #2	55	123	Upgrade	Replace with new 200 gpm pumps	$24,000
7.PS03	Blue Ridge	70		Decommission	Installation of intertie to new gravity sewers	$17,000
7.PS04	Blue Ridge	70		Decommission	Removal of Pump Station	$26,000
7.PS05	Darnell Estates	170		Decommission	Construction of a 300-foot 8” Sewer	$52,000
7.PS06	Darnell Estates	170		Decommission	Removal of Pump Station	$26,000
7.PS07	Desert Skies	95		Decommission	Construction of a 550-ft 8” Sewer	$91,000
7.PS08	Desert Skies	95		Decommission	Removal of Pump Station	$26,000
7.PS09	Ridgewater #1	118		Decommission	Construction of 250-foot 8” Sewer	$41,000
7.PS10	Ridgewater #1	118		Decommission	Removal of Pump Station	$26,000
7.PS11	Sun Meadows	380		Decommission	Construction of 1500-foot 8” Sewer	$216,000
7.PS12	Sun Meadows	380		Decommission	Removal of Pump Station	$26,000
8.PS02	Old Mill	300	504	Upgrade	Installation of 2 new 600-gpm VFD pumps	$57,000
8.PS03	River Rim	150	229	Upgrade	Installation of new 200-gpm pumps	$46,000
8.PS06	South Village	265		Decommission	Construction of 400-ft 8” trunk sewer	$67,000

TABLE 7B
Pump Station Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Lift Station Name	Existing Firm Capacity from CSMP (gallons per minute)	Applicable 2028 Peak Flow Estimate (gallons per minute)	Improvement	Improvement Description	Cost
8.PS07	South Village	265		Decommission	Removal of Pump Station	$26,000
9.PS01	Summit Park	125		Decommission	Construction of new 500-ft 8" gravity sewer	$83,000
9.PS02	Summit Park	125		Decommission	Removal of Pump Station	$16,000
	Westside	3,000	5,750	Replacement	Improvements to Westside Pump Station	$3,994,000
Total						**$7,852,000**

Notes:

Improvements represent system upgrades to service population and flow estimates through 2028 within the UGB. Improvements reflect pump stations servicing major collectors and interceptors. Additional improvements may be required to minor pump stations based on development needs. All costs are order-of-magnitude in 2010 dollars. Pump station improvement costs were not independently estimated, resulting in a reduced level of accuracy. The 2006 CSMP pump station improvements costs (identified by MWH in the original CSMP) are either reduced or increased based on the "six-tenths capacity factor" rule.

TABLE 7C
Interceptor Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
Central Interceptor										
Gravity Segment	24	4 - 28	20,100	$5,132,000	42	$711,000	$1,169,000	$1,753,000	$2,630,000	$11,395,000
Force Main Segment (from Westside Pump Station)	21	2 - 11	1,000	$169,000			$34,000	$51,000	$76,000	$330,000
Total			**21,100**	**$5,301,000**	**42**	**$711,000**	**$1,203,000**	**$1,804,000**	**$2,706,000**	**$11,725,000**
North Interceptor										
Juniper Ridge to Hwy 97	36	5 - 14	2,500	$640,000	5	$79,000	$144,000	$216,000	$324,000	$1,403,000
Parallel Plant Interceptor to Juniper Ridge	36	4 - 16	12,400	$3,125,000	21	$316,000	$688,000	$1,032,000	$1,548,000	$6,710,000
Total			**14,900**	**$3,765,000**	**26**	**$395,000**	**$832,000**	**$1,248,000**	**$1,872,000**	**$8,113,000**
Southeast Interceptor										
Murphy Rd Pump Station to Hwy 97	18	5 - 24	5,900	$1,879,000	29	$540,000	$484,000	$726,000	$1,088,000	$4,716,000

TABLE 7C
Interceptor Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
Murphy Rd Pump Station to Hwy 97	24	16 - 28	900	$340,000	29	$540,000	$68,000	$102,000	$153,000	$662,000
SE 15th to Murphy Rd Pump Station	24	10 - 35	2,900	$1,389,000	8	$166,000	$311,000	$466,000	$700,000	$3,031,000
Reed Market Rd to SE 15th St	24	10 - 20	1,900	$490,000	53	$990,000	$296,000	$444,000	$666,000	$2,886,000
Reed Market Rd to SE 15th St	30	9 - 22	7,500	$2,839,000			$568,000	$852,000	$1,277,000	$5,535,000
Hwy 20 to Reed Market Rd	24	8 - 15	3,200	$646,000	19	$329,000	$195,000	$293,000	$439,000	$1,902,000
Hwy 20 to Reed Market Rd	30	15 - 26	3,100	$1,448,000			$290,000	$434,000	$652,000	$2,824,000
North Unit Canal to Hwy 20	24	6 - 25	13,700	$3,582,000	37	$614,000	$839,000	$1,259,000	$1,888,000	$8,183,000
Total			**39,100**	**$12,613,000**	**146**	**$2,639,000**	**$3,051,000**	**$4,576,000**	**$6,863,000**	**$29,739,000**

TABLE 7C
Interceptor Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
Parallel Plant Interceptor Option A										
North Connection	36	3 - 26	3,100	$1,325,000	7	$135,000	$292,000	$438,000	$657,000	$2,846,000
Interceptor Option A	24	8 - 15	1,900	$428,000	45	$725,000	$231,000	$346,000	$519,000	$2,249,000
Interceptor Option A	30	8 - 26	9,300	$2,628,000			$526,000	$788,000	$1,183,000	$5,125,000
Interceptor Option A	36	4 - 19	7,100	$1,982,000			$396,000	$595,000	$892,000	$3,866,000
Total			**21,400**	**$6,363,000**	**52**	**$860,000**	**$1,445,000**	**$2,167,000**	**$3,251,000**	**$14,086,000**
Parallel Plant Interceptor Option B										
North Connection	36	8 - 26	2,000	$932,000	4	$83,000	$203,000	$304,000	$457,000	$1,979,000
Interceptor Option B	24	8 - 15	1,700	$375,000	51	$849,000	$245,000	$367,000	$551,000	$2,387,000
Interceptor Option B	30	8 - 26	9,500	$3,082,000			$616,000	$925,000	$1,387,000	$6,010,000
Interceptor Option B	36	9 - 22	1,100	$381,000			$76,000	$114,000	$171,000	$743,000

TABLE 7C
Interceptor Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
Interceptor Option B	42	4 - 19	7,900	$2,473,000			$495,000	$742,000	$1,113,000	$4,823,000
Total			**22,200**	**$7,243,000**	**55**	**$932,000**	**$1,635,000**	**$2,452,000**	**$3,679,000**	**$15,942,000**
Parallel Plant Interceptor Option C										
JD Estates Dr to North Unit Canal	24	8 - 14	2,600	$623,000	13	$208,000	$166,000	$249,000	$374,000	$1,619,000
JD Estates Dr to North Unit Canal	30	8 - 15	3,100	$847,000			$169,000	$254,000	$381,000	$1,651,000
North Interceptor Junction to JD Estates Dr	30	7 - 12	3,900	$1,078,000	8	$129,000	$241,000	$362,000	$543,000	$2,353,000
North Interceptor Junction to Siphon	36	4 - 9	5,700	$1,298,000	18	$283,000	$316,000	$475,000	$712,000	$3,084,000
North Interceptor Junction to Siphon	42	6 - 18	3,300	$1,147,000			$229,000	$344,000	$516,000	$2,237,000

TABLE 7C
Interceptor Capital Improvements and Costs
Bend Collection System Master Plan Addendum No. 4

Improvement	Improvement Diameter (inch)	Depth Range (feet)	Pipeline Length (feet)	Pipeline Material & Installation Cost	Manholes	Manhole Material & Installation Cost	Other Costs (Easements, Crossings, Etc.) @20%	Engineering, Legal, and Administration Cost @25%	Contingency Cost @30%	Total Cost
Siphon	36	3 - 12	4,300	$985,000	7	$104,000	$218,000	$327,000	$490,000	$2,124,000
Total			**22,900**	**$5,978,000**	**46**	**$724,000**	**$1,339,000**	**$2,011,000**	**$3,016,000**	**$13,068,000**

Notes:

Improvements represent new interceptors to service population and flow estimates through 2028 within the UGB. All costs are order-of-magnitude, -30% to +50% in 2010 dollars.

Capacity Analysis

A capacity analysis was performed to identify areas of surplus or limited capacity in the sanitary sewer collection system for both existing and 2028 populations and sewage flows. This analysis is based on the hydraulic modeling completed in January 2011 in response to the remand requirements to align the City's Public Facilities Plans with the General Plan. This capacity analysis is based on the current and future parameters and assumptions used in the remand response document.

Existing System Analysis

In order to quantify existing system excess capacity, the existing sanitary sewer system model was run with existing (2010 population) flow rates including infiltration and inflow from wet weather conditions. Excess capacity was determined by subtracting peak model flow rate from the full pipe design flow rate for each individual pipeline in the model. The existing system model only considers major collectors and interceptors.

Once the difference between the full pipe capacity and the peak modeled flow was determined, excess capacity in each pipeline was converted to equivalent dwelling units (EDUs) assuming 250 gallons per day per unit and an instantaneous peaking factor of 3.0 (3.0 × 100 gallons per capita per day [gpcd] × 2.5 people per unit). The instantaneous peaking factor was developed by sampling pipelines throughout the model and comparing the ratio of peak flow to average flow.

Existing System Results

Results of the existing system excess capacity analysis are presented in Figure 4. The map shows pipeline excess capacity in EDUs compared to the estimated number of new EDUs by 2028 for each study area. EDUs shown are <u>not</u> the expected number of new housing units to be accommodated; rather, they are a measure of capacity that may also be used for new, non-residential developments, such as industrial and commercial uses. Generalizations are presented below:

1. The purpose of the existing system excess capacity analysis is to generally show the number of pipelines requiring replacement if the interceptor improvements are not implemented. If the number of new EDUs shown for a given service area plus the number of new EDUs in all upstream service areas exceeds the available excess capacity in a given pipeline, an improvement is required. Following this logic, many of the pipeline segments between downtown and the WRF would require improvements.

2. Many of the collection system deficiencies will be eliminated by constructing the Central, North, Southeast, and Parallel Plant interceptors.

3. Smaller collectors with less than 1,000 EDUs excess capacity will require improvement with limited growth in each study area.

4. Areas with the least excess capacity are Study Areas 4, 5, 6, and 7. These areas include the north and south perimeter of the City and downtown. These areas are best served in the future by constructing the Central, North, and Southeast interceptors.

5. Study Areas 1, 2, 4, 5, and 7 are limited by available capacity of gravity pipelines and pump stations. The interceptor improvements eliminate upsizing of pump stations in some of these areas.

6. The overall system is projected to grow by an additional 28,200 EDUs by 2028. Segments of the existing plant interceptor have limited excess capacity. A parallel plant interceptor will be required to serve 2028 growth estimates.

7. As previously stated, the Westside Pump Station has limited excess capacity for future growth as currently configured. The capacity of the Westside Pump Station is directly affected by construction of the downstream interceptors (Central, North, and Parallel Plant interceptors). Any interim condition where the downstream interceptors are not fully constructed may result in a hydraulic deficiency beginning at the Westside Pump Station and going downstream. Interim conditions may also cause backwater from the pump station into the upstream collection system. Additionally, the City has a goal to maximize gravity sewer and minimize pump station usage throughout the City to minimize O&M costs. Any proposed interim improvement at the Westside Pump Station prior to construction of the downstream interceptors should consider a 50-year cost analysis that includes O&M costs. The overall cost estimate for improvements downstream of the Westside Pump Station, including the pump station and all downstream interceptors, is $39,774,000 in 2010 dollars (see Table 6).

2028 System Analysis

In the same manner that the model was run with the 2010 population, an excess capacity analysis was also performed for the 2028 improved collection system to generalize where additional deficiencies may occur if land-use classifications are modified for increased parcel density. This analysis presumes that the system deficiencies identified in the 2010 CIP will have been corrected. The future system excess capacity scenario is described below:

The 2028 system model was run with 2028 flow rates during wet weather conditions and all 2028 capital improvements as identified in Addendum No. 4. Excess capacity was determined by subtracting peak model flow rate from the full pipe design flow rate for each individual pipeline. Excess capacity was converted to equivalent dwelling units (EDUs) assuming 250 gallons per day per unit and a peaking factor of 3.0 (3.0 ×100 gpcd × 2.5 people per unit).

2028 System Results

Results of the future system excess capacity analysis are presented in Figure 5. The map shows pipeline excess capacity in EDUs. Generalizations are presented below:

1. The improvements identified in the CIP of Addendum No. 4 provide adequate capacity for growth in main collectors and interceptors through 2028. Additional improvements may be required beyond 2028 within the existing UGB.

2. The Central, North, and Southeast Interceptors improve capacity in the north and south perimeter and downtown areas. The Parallel Plant Interceptor improves capacity for the entire City of Bend.

3. Additional improvements may be required to some existing system pipelines if land-use classifications are modified to increase parcel density. This is most applicable to Study Areas 6, 8, and 9.

4. The interceptor improvements have some excess capacity for growth beyond 2028. For example, the Central and North Interceptors have between 5,000 and 10,000 EDUs excess capacity; while the Southeast Interceptor has between 1,000 and 5,000 EDUs excess capacity. The additional growth is anticipated for new services within the UGB beyond 2028; however, the interceptors were not sized for ultimate build-out conditions.

The estimates of EDUs for the excess capacity analysis are approximate and based on the capacity of a full flowing pipeline and a realistic but conservative peaking factor. The intent of the analysis is to provide generalizations about the available capacity of the existing and future systems. Figures 4 and 5 should be used for these generalizations and not for new development approval. Development specific modeling should be conducted prior to establishing available capacity for new development.

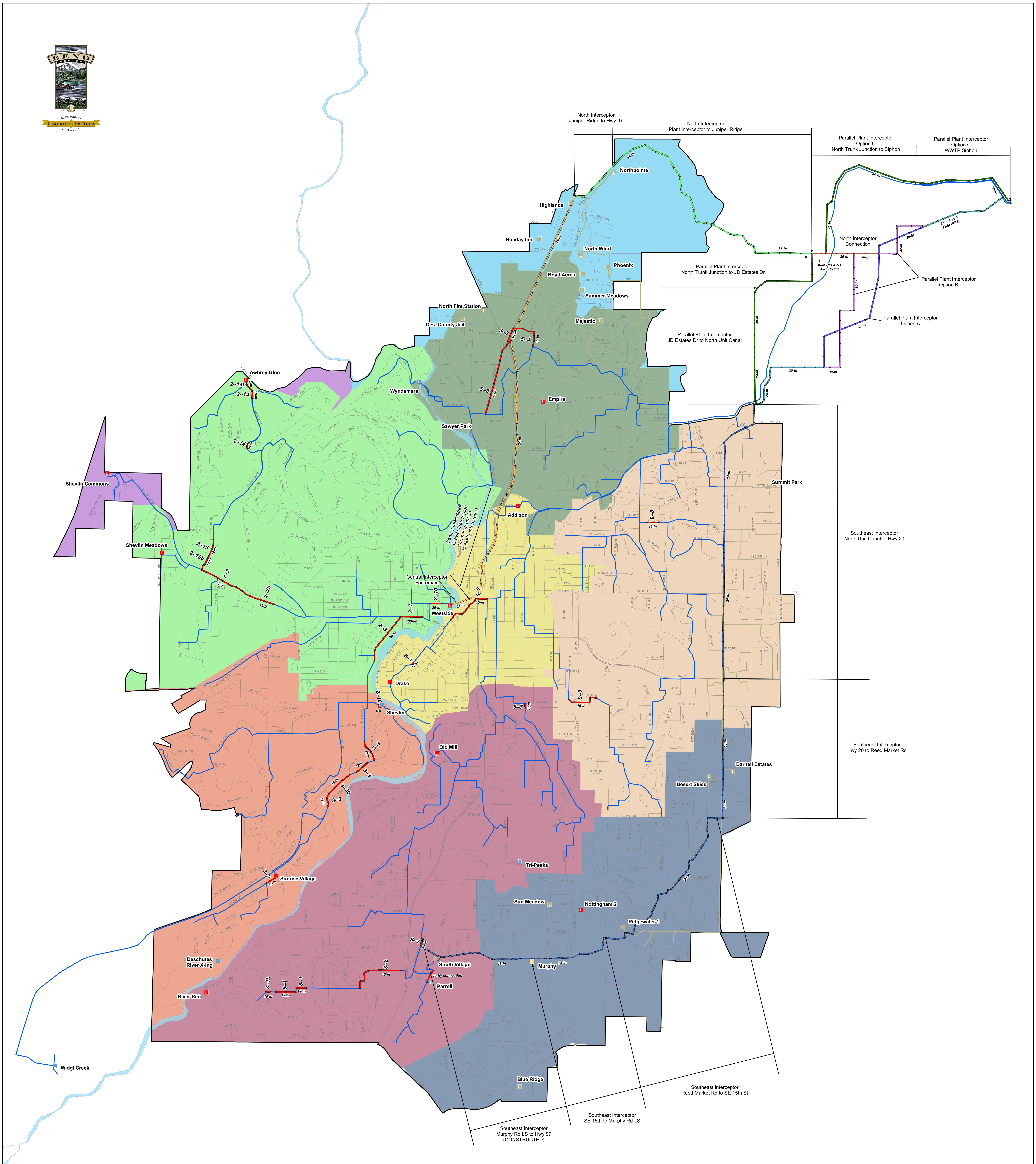

FIGURE 3
CITY OF BEND, OREGON
COLLECTION SYSTEM
CAPITAL IMPROVEMENT PROGRAM

- Manhole
- Pipeline
- Existing UGB

Lift Station
- Decommission
- Improvement
- Interim Improvement
- No Improvement

Pipeline Improvement
- North Interceptor
- Southeast Interceptor
- Central Interceptor
- Parallel Plant Interceptor Option A
- Parallel Plant Interceptor Option B
- Parallel Plant Interceptor Option A or B
- Parallel Plant Interceptor Option C
- North Connection
- Existing Pipeline Improvement

Study Area
1, 2, 3, 4, 5, 6, 7, 8, 9

0 2,500 5,000
Feet

Note: Improvements represent system upgrades to service population and flow estimates through 2028 within the existing UGB. Improvements reflect major collectors, interceptors, and pump stations servicing major collectors and interceptors. Additional improvements may be required to minor collectors, service lines, and minor pump stations based on development needs.

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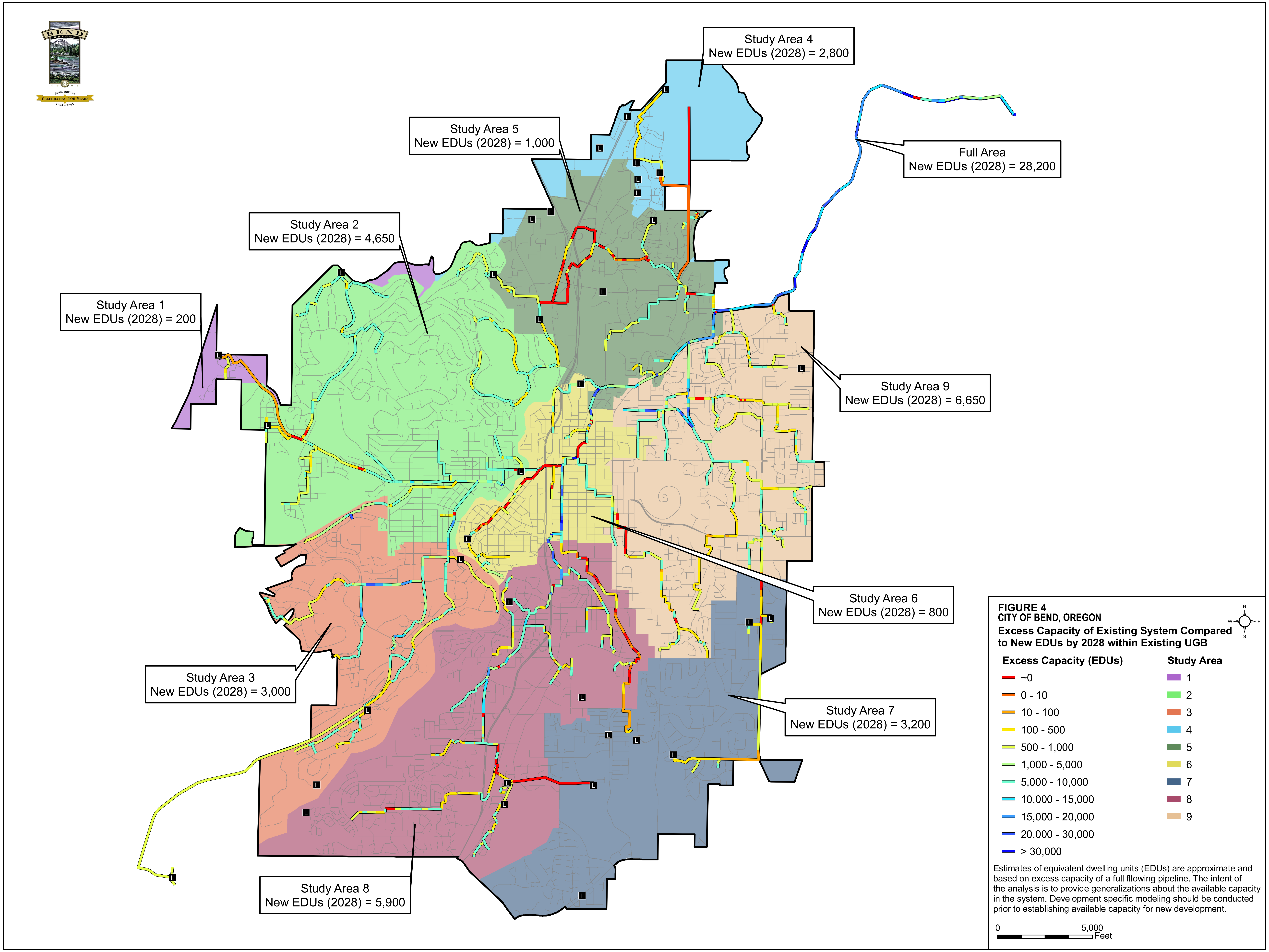
Study Area 1
New EDUs (2028) = 200
Study Area 2
New EDUs (2028) = 4,650
Study Area 3
New EDUs (2028) = 3,000
Study Area 4
New EDUs (2028) = 2,800
Study Area 5
New EDUs (2028) = 1,000
Study Area 6
New EDUs (2028) = 800
Study Area 7
New EDUs (2028) = 3,200
Study Area 8
New EDUs (2028) = 5,900
Study Area 9
New EDUs (2028) = 6,650
Full Area
New EDUs (2028) = 28,200
FIGURE 4
CITY OF BEND, OREGON
Excess Capacity of Existing System Compared to New EDUs by 2028 within Existing UGB
Excess Capacity (EDUs)
~0
0 - 10
10 - 100
100 - 500
500 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 15,000
15,000 - 20,000
20,000 - 30,000
> 30,000
Study Area
1
2
3
4
5
6
7
8
9
Estimates of equivalent dwelling units (EDUs) are approximate and based on excess capacity of a full flowing pipeline. The intent of the analysis is to provide generalizations about the available capacity in the system. Development specific modeling should be conducted prior to establishing available capacity for new development.
0
5,000
Feet

CH2MHILL

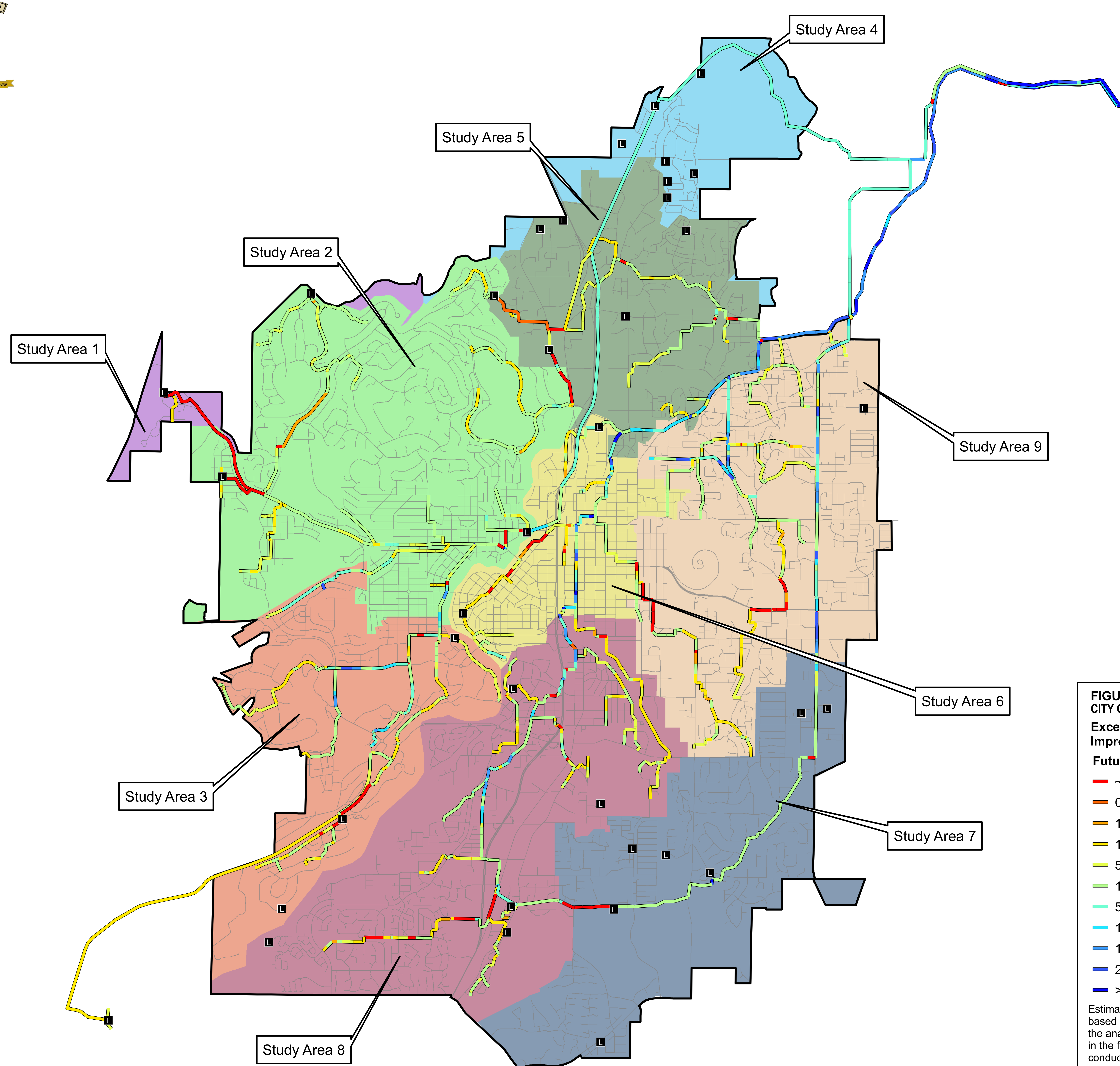

FIGURE 5
CITY OF BEND, OREGON

Excess Capacity of Future System with 2028 Improvements within Existing UGB

Future Excess Capacity (EDUs)	Study Area
~0	1
0 - 10	2
10 -100	3
100 - 500	4
500 - 1,000	5
1,000 - 5,000	6
5,000 - 10,000	7
10,000 - 15,000	8
15,000 - 20,000	9
20,000 - 30,000	
> 30,000	

Estimates of equivalent dwelling units (EDUs) are approximate and based on excess capacity of a full flowing pipeline. The intent of the analysis is to provide generalizations about the available capacity in the future system. Development specific modeling should be conducted prior to establishing available capacity for new development.

0 5,000 Feet

CH2MHILL